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Floral biology and pollination in *Stylosanthes fruticosa* (Retz.) Alston (Fabaceae)

Rohini Latha K✉, **Tirupati Rao YRKV**

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Author Affiliation:
Department of Botany & Microbiology, Acharya Nagarjuna University, Nagarjuna Nagar, Guntur, Andhra Pradesh 522 510, India

✉**Corresponding author**:
K. Rohini Latha, Department of Botany & Microbiology, Acharya Nagarjuna University, Nagarjuna Nagar, Guntur, Andhra Pradesh 522 510, India
Email: komminirohinilatha2021@gmail.com

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ABSTRACT

Stylosanthes fruticosa is a typical hermaphroditic procumbent under-shrub. It is autogamous but it is also melittophilous and psychophilous. Fruit is a typical pod and the seed dispersal involves autochory and hydrochory. This under-shrub with huge mat-like population produces heavy seed output and contributes a high load of seed bank in the soil. Field observations indicate that it is useful for land reclamation, soil stabilization, soil fertility and as a forage crop for cattle.

Key words:
Stylosanthes fruticosa, hermaphrodism, melittophily, psychophily, autochory, hydrochory

1. INTRODUCTION

The genus *Stylosanthes* (Family Fabaceae, sub-family Faboideae, tribe Aeschynomeneae, sub-tribe Stylosanthinae) consists of 48 herbaceous sub-shrub species (Costa, 2006) distributed mostly in tropical, sub-tropical and warm temperate regions of Americas (Ferreira and Costa, 1979). It is highly valued for pasture and forage species (Lavin et al. 2001; Cardoso et al. 2013) because most of the species in this genus have the ability to fix atmospheric nitrogen, improve soil fertility and provide high protein content (Coates et al. 1997). Seeds are viable for a long period and form a high load of seed bank in the soil; they have the ability to recover rapidly from heavy grazing and fire. The grazing animals devour seeds while grazing on the *Stylosanthes* pastures but the seeds pass out through the digestive system unaffected, remain viable and germinate to produce new plants (Cameron and Chakraborty 2004). Within the genus, many species have been reported to be drought resistant and have adaptations to hot and dry conditions (Jones et al. 1997). In India, *Stylosanthes* species are extensively utilized in pastoral, agro-pastoral and silvi-pastoral systems in humid and semi-arid tropical portions for animal production. This genus is very important for the restoration of soil fertility, improvement of physical properties of soil and for providing permanent vegetation cover (Chandra et al. 2006).

The genus *Stylosanthes* is reported to be primarily self-pollinated (Bray and Hutton, 1976). Molecular study on mating systems in *S. capitata* and *S. guianensis* showed that these two species display mixed mating system with

autogamy as a predominant mode (Melissa de Oliveira et al. 2010). There is no information on the pollination ecology of all other *Stylosanthes* species. With this backdrop, *S. fruticosa* has been studied for its floral and pollination aspects because of its forage value for grazing cattle and to understand how this species is able to produce populations through sexual mode of reproduction.

2. MATERIALS AND METHODS

Stylosanthes fruticosa growing in the areas of agricultural fields (Figure 1a) in the outskirts of Guntur (16.3067° N Latitude and 80.4365° E Longitude), Andhra Pradesh, India, was selected for study during 2020-2021. Vegetative growth, flowering and fruiting events were examined continually from the time of appearance of plants and until they withered following seed dispersal. The floral details were examined with reference to the possible pollination system and its reliance on insect pollinators. The flower foragers were observed to record the role of individual species in the pollination of this plant. Fruit growth and development, maturation, dehiscence and seed dispersal aspects were critically observed to note the recruiting potential for the production of populations by this plant.

Figure 1. *Stylosanthes fruticosa*: a. Habit, b. & c. Flowering phase, d. Twig with flowers, e. *Ceratina* sp. collecting pollen, f. & g. Lycaenid butterflies – *Leptotes plinius*, g. *Zizeeria karsandra*.

3. RESULTS AND DISCUSSION

S. fruticosa (=*mucronata* Willd.) is a short-lived perennial woody procumbent under-shrub with pubescent stems and tri-foliate elliptic pubescent leaflets. The flowers are small, pedicellate, zygomorphic, bisexual, solitary but they are also borne in 3-5 flowered terminal heads in leaf axils (Figure 1d). They are open early in the morning and remain in place for two consecutive days. Calyx is green, hairy, short-tubed and terminally 4-lobed with the upper one notched at the top, lower lobe kee-like and lateral 2 lobes triangular. The corolla is yellow, papilionaceous with standard petal, two wing and two keel petals. The standard petal is erect, wedge-shaped claw with red nectar veins/lines in the center and they run towards the corolla base leading to the placement of nectar. The wing petals with linear claws are fused along the tip around keel petals which are fused on lower side from mid-point to the tip. The stamens are 10 and fused into a columnar sheath characterizing monoadelphous condition. The anthers are yellow, dithecous and dorsifixed; they dehisce by longitudinal slits during mature bud stage and disseminate light yellow pollen grains. The pistil consists of ellipsoid, green and woolly ovary with 2 ovules, filiform style and terminal minute stigma. Fruit is a pod, densely hairy and breaks into 2 units of which the upper unit is 1-seeded while the lower unit is infertile. The seeds are yellowish-brown, reniform, compressed and beaked near the hilum.

The study shows that *S. fruticosa* initiates flowering during late wet season (Figure 1b,c), reaches peak phase during November-December and then flowering ceases by the end of January. Since the plant produces huge patches, the yellow flowers appear prominent against green foliage and attract small bees (*Ceratina* spp. –Figure 1e) and small butterflies (*Leptotes plinius* – Figure 1f and *Zizeeria karsandra* – Figure 1g) belonging to Lycaenidae. The flowers produce nectar in trace amount at corolla base and concealed by standard petal. Since the flowers are small and petals are delicate, the small bees, are able to press the keel petals

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down to access nectar and then, the stigma and the dehisced anthers get released and strike the ventral portion of the bee body. As a consequence, pollen transfer from the bee body (from the previously visited flowers) to the stigma and from the anthers to bee body occurs spontaneously leading to the occurrence of pollination. The close proximity of both anthers and stigma within the keel facilities the occurrence of autogamy any time during flower life if not visited by bees and butterflies. Butterflies are not effective to access the nectar but they are able to gather nectar from the flowers that were already visited by bees. *S. fruticosa* is mainly autogamous but also utilize insects for self- as well as cross-pollination through which genetic variation is ensured. Bees act as main pollinators while butterflies as supplementary pollinators. The study agrees with the report that *Stylosanthes* genus is primarily self-pollinated (Bray and Hutton, 1976) and that mixed mating system with autogamy as a predominant mode in *S. capitata* and *S. guianensis* (Melissa de Oliveira et al. 2010). Therefore, the study substantiates that *Stylosanthes* species are typically self-pollinated and *S. fruticosa* is also not an exception.

S. fruticosa produces fruits within a month time from the time of occurrence of fertilization. Fruit is a pod which breaks open into two units exposing the seed but seed dispersal through autochory is not effective and the dehisced pods upon reaching the ground remain in the soil. Gradually, seeds find their way into soil but germinate only during late rainy season to produce new plants. Seeds also disperse by rain water during wet season indicating the function of hydrochory. The study reports that *S. fruticosa* with huge mat-like population produces heavy seed out and contributes a high load of seed bank in the soil. It is useful for land reclamation, soil stabilization, soil fertility and as a forage crop for cattle.

4. CONCLUSIONS

S. fruticosa is a hermaphroditic species. The flowers with papilionaceous corolla are autogamous but pollinated by bees and butterflies; the former foragers act as principal pollinators while the latter foragers as supplementary pollinators. Fruit is a typical pod which breaks open into two units exposing the seed but seed dispersal through autochory is not effective and the dehisced pods upon reaching the ground remain in the soil. The seeds germinate only during late rainy season to produce new plants. Seeds also disperse by rain water during wet season indicating the function of hydrochory. The study reports that *S. fruticosa* with huge mat-like population produces heavy seed output and contributes a high load of seed bank in the soil. It is useful for land reclamation, soil stabilization, soil fertility and as a forage crop for cattle.

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Authors contributions

Both authors contributed equally.

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Ethical approval

The ethical guidelines for plants & plant materials are followed in the study for species collection & identification.

Conflicts of interest:

The authors declare no conflict of interest.

Data and materials availability

All data associated with this study are present in the paper.

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